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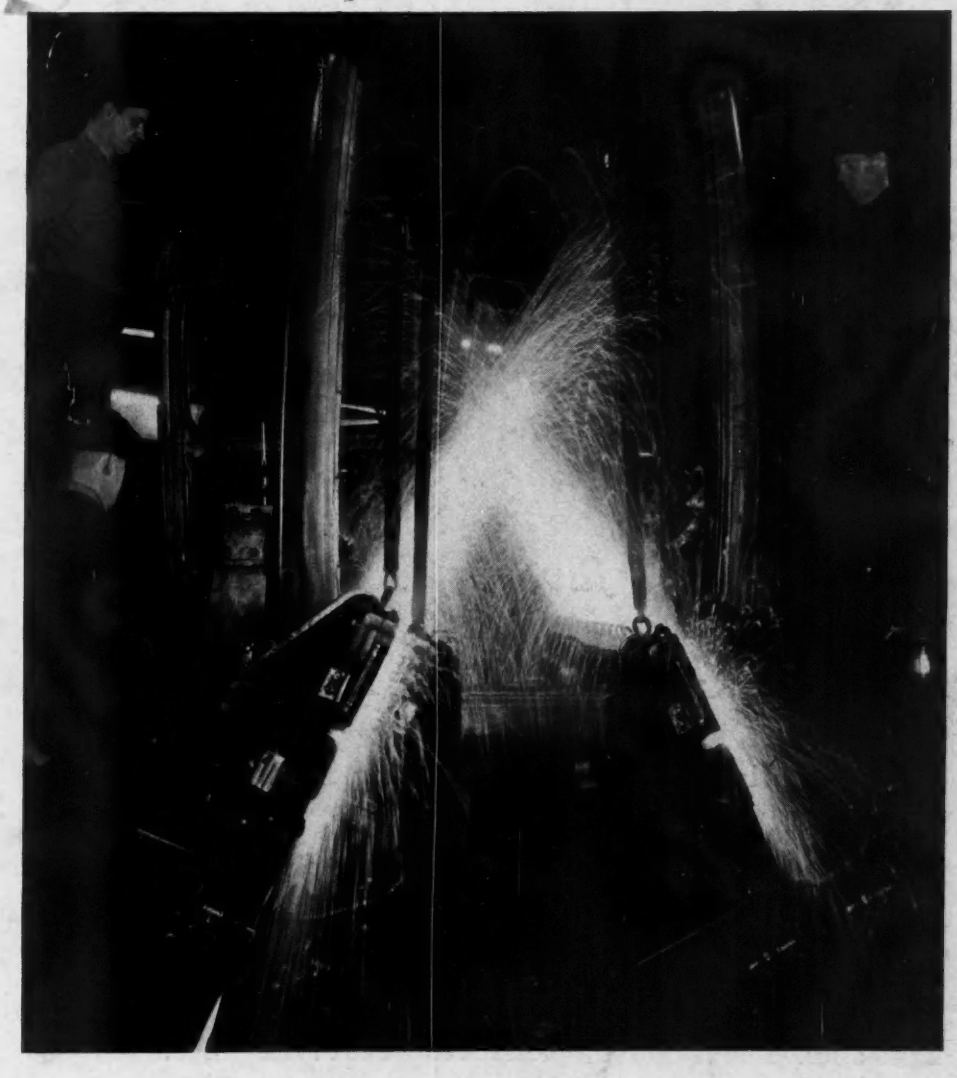

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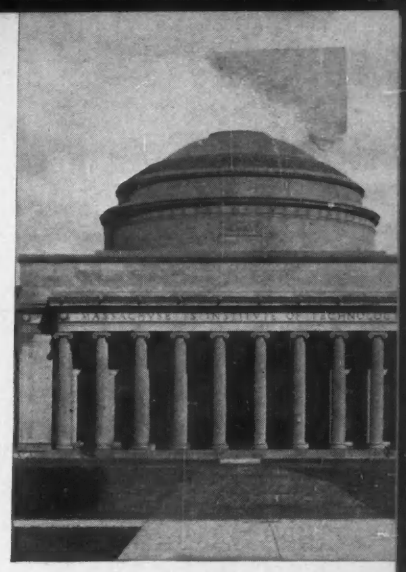

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—*Mechanical Engineering*

MAKING THE WHEELS GO 'ROUND

THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME XV MARCH, 1934 NUMBER 1

MUNICIPAL POLICE COMMUNICATIONS

By CARLTON E. TUCKER
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IN order to serve the communications needs of a municipal police department a system is required which will perform the following functions:

1. Provide for ready communication between the public and the police.
2. Provide for the receiving of emergency telephone calls from the public over a special group of telephone trunks selected, from any point in the city in question, by calling a single emergency telephone number.
3. Provide that accurate records be made of all alarms received and also provide that a record be made of their disposition.
4. Provide for two-way communication between patrolmen on foot and in patrol cars and their senior officers.
5. Provide for communication with the police agencies of neighboring municipalities.

A system which will perform the foregoing functions requires the following services, most of which are usually employed more or less completely in the larger cities:

1. Connections with the public telephone system.
2. A patrol-box system with citizens' alarm and officers' recall.
3. The teletype.
4. Two-way radio communication between commanding officers and all mobile units of a police department.

Connections with the Public Telephone System

Emergency calls from the public to a police department usually come in as a call over the public telephone system, as a personal call at a police station, or by means of a citizen's alarm over the patrol-box system. Telephone calls are usually made by calling a special police emergency number, as, for example, "POLice 1313" in Chicago, or by saying "Police-Emergency" to the telephone operator. In some large cities such calls terminate on a specially designed telephone switchboard entirely separated from the usual switchboard for business calls. An operator, who is usually specially trained for dealing with the public, obtains the complete story of each complaint with necessary names and addresses. All of this information is recorded on a suitable blank. The person making the complaint is not connected through to the

Technique

officer who will act upon his complaint and has to tell his story but once. The action taken depends upon the nature of the complaint. The operator reports minor troubles, by telephone, to the station house which has jurisdiction, for action in due course. Ambulance calls are relayed to the nearest hospital or station house which has such facility as is necessary available at the time. Reports of stolen cars, robbery, murder, kidnapping, and major crimes in general are broadcast over the radio to inform patrol cars of all police departments in the vicinity, and they are sent out over the teletype to notify the detective bureau, all station houses, and neighboring police departments. The broadcasting is sometimes done directly by the operator receiving the alarm, or the message blank is handed to a radio dispatcher or teletype operator, or both. In all cases where cars are dispatched by means of radio, the officer in charge in the car is required to call the radio dispatcher, over either the patrol-box or the public telephone system or by two-way radio, and report on his assignment. The message blank is kept on an active file until the case is reported as being acted upon by some member of the department.

Business telephone calls to a police department are usually placed by calling a telephone number which differs from the emergency number. The calls are then handled by a different group of operators and by means of a separate switchboard from the one which receives alarms. The business switchboard has connections to telephones in the offices of police headquarters and often direct lines to telephones or switchboards in station houses, courts, and hospitals. In case an emergency call comes into the business switchboard there is often provision to switch the call to the operator who makes the records of complaints. A business call which comes to the emergency switchboard is usually refused, and the person instructed to call the business telephone number.

The Patrol-Box System

Most cities employ a patrol-box system to provide for reporting by the men on patrol. The report is made by the movement of a lever or "hook." The actuation of the hook causes a series of electrical pulses to be sent over a wire circuit to the station house. These pulses

record on a tape register in the station house and indicate the number of the box from which the call was made and, in some cases, a code intended to identify the particular patrolman making the report. By appropriate operation of the hook, a call for a patrol wagon is indicated on the register at the station house. The time of the report or wagon call is printed on the tape by the operation of a time stamp.

Patrol boxes generally contain a telephone set. By means of this, a patrolman may signal and converse with senior officers in the station house. In many cases all the boxes on a cable run are connected on a common line. There is, however, a tendency towards using an individual telephone pair to connect each box to its station house.

The commanding officers often desire to locate a particular patrolman or even the entire force. Many cities employ recall systems to attract the officers to the patrol-box telephones to receive information and orders. The recall signal usually takes the form of a flashing red light although sometimes blue or purple lenses are used. Occasionally bell or horn signals are employed. These latter are not frequent, because of public complaint at being disturbed by the noise.

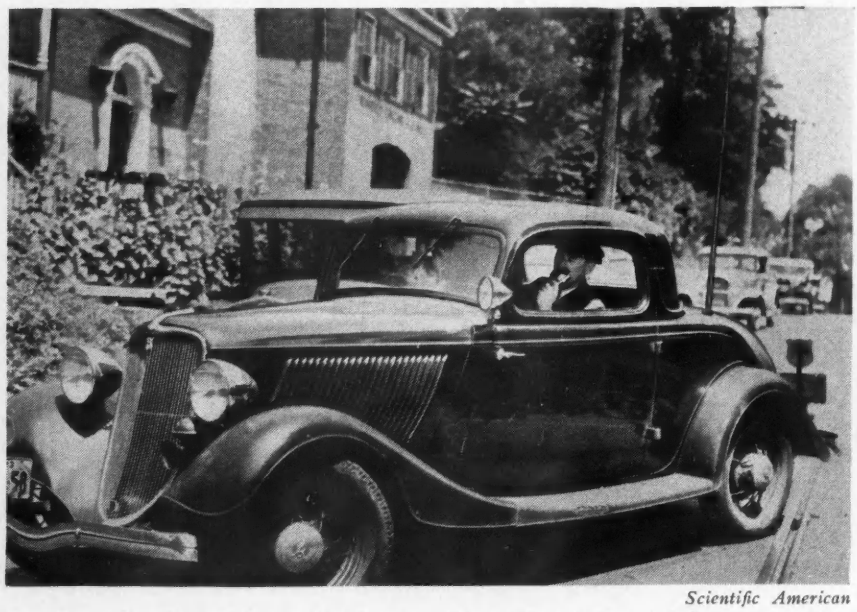
Fig. 2 — The Hayes patrol box with recall lamp at the top and the citizens' hook in the recess below the door.

A few cities make provision for citizens' alarms sent in by the insertion of a special key into any box. The turning of the key in the box serves to send a series of pulses over the wires to the station house. These pulses are recorded on the tape register. These keys are distributed to certain citizens who might have occasion to use them. Each key is numbered and recorded in the name of the person to whom issued. After insertion in a patrol box it cannot be removed except by opening the box, so that it can be determined whose key was responsible for the alarm.

A system employing hooks on the outside of the patrol boxes, which hooks may be pulled by anyone, has been developed by Mr. T. A. J. Hayes, Director of Signal Service of the Boston Police Department. The pulling of the hook serves to start a special signalling motor-generator set at the station house, and to send out pulses to the recall lights to indicate the number of the box from which the alarm has been sent, in addition to operating the tape register and time stamp at the station house. Patrol cars and a patrol wagon generally respond to the location of a citizen's alarm. This system is open to the objection of more false alarms than the system employing a key. However, experience has shown that these are no more numerous than in a fire alarm system. The advantages of having each box serve as a fixed-post patrolman greatly outweigh the disadvantages of the relatively small number of false alarms.

The Boston box with the recall lamp on top and the citizens' hook in the recess below the door as devised by Mr. Hayes is illustrated in Fig. 2. The lamp used has a straight side filament, the lens is ruby and the flashing may be readily noticed even on a bright day for one or two thousand feet.

In general the telephone connection from a patrol box does not extend beyond the station house. In some cities, however, the station houses are interconnected through general headquarters by means of a cable running to a manual or a dial telephone switchboard. In this case any member of the department may talk to any point in the department. This is a particularly desirable way for patrol cars to report on the results of their assignment. It is not common practice for these police telephone systems to interconnect with the public telephone system although this is done in two large cities. Occasionally there is telephone connection with the private police telephone systems of adjoining cities.



Scientific American

Fig. 3 — A radio-equipped police cruiser. The telescoping aerial for transmitting is shown protruding vertically from the rear of the car and fully extended.

The signal desk recommended by the Technology survey of 1931-32 for use in the station houses of the Boston Police Department, and as developed by the department, is shown in Fig. 5. The central portion is essentially a telephone switchboard with a line lamp and an answering jack for each patrol box, for each station house departmental telephone and for each trunk connecting to a dial switchboard, soon to be placed at General Headquarters. This dial switchboard will serve to interconnect these signal desks (of which four are now in service), the departmental telephones in the General Headquarters building, the radio dispatcher, and finally the radio-equipped cars. On top of the signal desk are, from left to right, the tape register, the time stamp, the viewing mirror, and a take-up reel. On the left panel are located an electric clock and a loud speaker which replaces the usual head telephone receiver. On the right panel are red caps over the recall pilot lamps and keys for operating the recall.

A report from a given patrol-box is

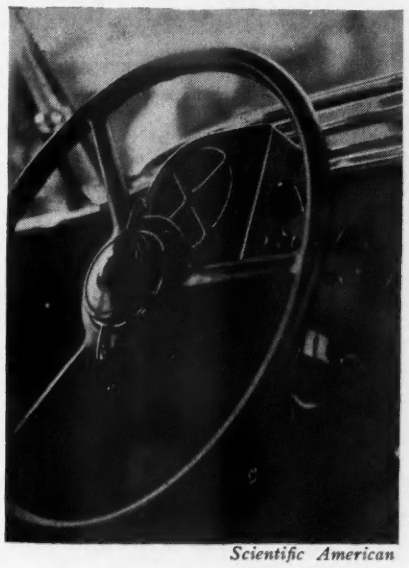


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Fig. 4 — Steering-column type equipment, showing the small dynamic speaker. The Boston system contemplates the use of a telephone receiver in addition to the speaker, it being possible to disconnect the latter, thus insuring maximum secrecy.

indicated by the lighting of its associated line lamp on the switchboard. The desk attendant uses any free rear plug in answering the call. Depressing the associated listening key puts the reporting call on the loud speaker. If the officer desires to be connected to any other telephone in the station house, or in General Headquarters, the forward cord of the pair is inserted into the appropriate jack and the called telephone signalled, either by means of the ringing key or by dial on the right of the key shelf, as required. Calls may also be made from any box to any car by wire and radio as described later. Flashing of a code number by a recall light on the right indicates the presence of a citizen's alarm and intermittent flashing by these lamps indicates a recall being sent out by the desk attendant.

In order to connect these patrol boxes with the station houses and provide an individual talking pair from each box it is necessary to employ small-gauge paper-insulated lead-covered telephone cable, to secure low capacitance, to conserve duct space and to give reasonable cost. Signalling current to operate the recall lamps is supplied over No. 8 gauge core conductors of this special signal cable. In order to avoid special cable terminals in the patrol boxes, a lead-covered lateral cable composed of high-quality rubber-insulated conductors is employed to connect from the main cable to the patrol box.

The Teletype

For distributing a typewritten record of alarms to the station houses of a police department, a network of teletype instruments is employed by most of the larger cities. It is not uncommon for the police departments of surrounding towns, as well as state police headquarters, to have teletype instruments on such a network. The teletype transmitting instrument is quite similar to a typewriter in appearance and its operation serves to cause telegraph signals to be sent out in such a way as to cause all receiving printers to type the same message. These machines are of the page type, requiring only that the attendant tear off the message in convenient form for filing. Some cities transmit all messages to every station, while others employ a separate line to each receiving teletype instrument and therefore may select, at will, which stations are to receive each message. An instrument for receiving only is shown in the extreme right of Fig. 5.

Radio Communication Between Commanding Officers and Mobile Units of a Police Department

A large number of cities in the country utilize short-wave radio, in the frequency band of 1700 to 2500 kilocycles per second, for transmitting alarms to the mobile units of their departments, such as cruising cars, motor cycles, police boats, and aeroplanes. One or more favorably-located transmitters, under the control of a dispatcher, usually cover a metropolitan area. In many cases the largest city of an area will arrange to broadcast for a large number of cities and towns in the surrounding area. This is done by such cities as Chicago and Cleveland. In other cases, as in Detroit, the larger city broadcasts to some of the adjoining cities and towns, while some broadcast for themselves. In this latter case all transmitters are interlocked by wire lines to prevent simultaneous operation. This is made necessary because of the fact that all cities in a metropolitan area are required, under existing rules of the Federal Radio Commission, to share a common frequency assignment. The power of these radio transmitters is generally low, depending upon the area and population served, and does not usually exceed 500 watts.

The car receivers are often of the tuned radio-frequency or superheterodyne circuit and are fixed tuned. They receive their filament supply from the car battery and the plate supply from batteries or from a vibrator or dynamotor, either of which latter is much more economical. The cars are equipped with loud speakers and in general with both manual and automatic volume controls. Some difficulty is usually experienced from dead spots due to the shielding effect of steel structures. This is often overcome by determining the location of these dead spots from experience and by refraining from stopping cars in these locations, as well as by repetition of the alarms broadcast. A check on all sets is usually made by means of sending test messages every fifteen minutes, particularly when radio traffic is light.

(Continued on page 20)

Fig. 5 — The signal desk as recommended by the Technology survey for use in the station houses of the Boston Police Department.

Romancing with the Microscope

A Study of Textile Technology

Fungus growth on rayon yarn shown at medium power through the textile microscope.

By EDWARD R. SCHWARZ

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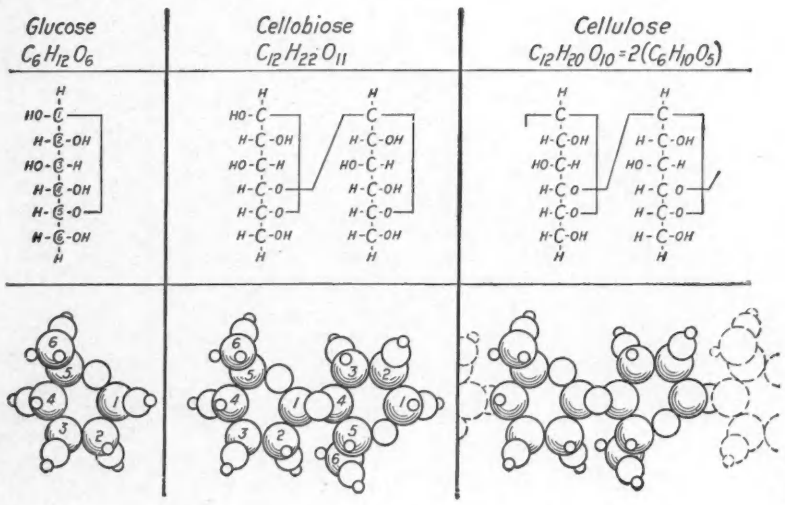
Fellow of the Textile Institute

WHETHER it be the furry pelt of the wild beast draped over the muscular torso of our equally savage cave man ancestor or the filmy rayon adorning the shoulders of the modern debutante, mankind has always been keenly interested in the texture of the garments which alike formed his protection from the elements and adorned his person. From the earliest times, even in the Garden of Eden, clothing has played a vital part in the development and destiny of the human race. Man has long endeavored to emulate the splendor of the Lily of the Field. But, even when he uses the very essence of the plant to color his modern fabrics, he falls short of achieving the tints and nuances of shade with which nature is so prodigal. He fails miserably to realize the enduring loveliness of the green leaf under ray of sun and drop of rain. He still has much to learn.

Although he realizes his shortcomings, he nevertheless —too often—guesses at the solution. He misses the obvious in his search for perfection. He fails to see the forest for the trees. It would seem childishly simple to look at what actually has been accomplished and to see it as it really is. But the human eye—wonderful optical masterpiece that it is—is limited in the scope of its vision. And since all the fibres which form the intimate structure of the yarn and fabric are too small to be seen with the unaided eye in all the detail of their truly marvelous structure, it is not to be wondered at that man should seek to find an aid to his sight.

Illustrations courtesy of K. H. Meyer—Kolloid Zeitschrift, and Bayerl and Roos—Kunsteide.



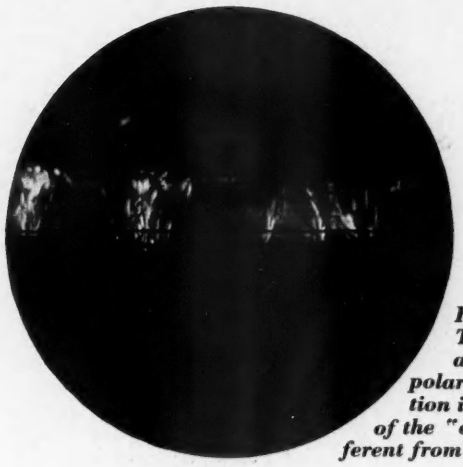
Empirical and structural formulae and space models for the ultimate structure of certain fibres.

The thrill which coursed through the body of the first man to gaze at the stars through the original crude telescope is only matched by the thrill that was reserved for the first microscopist. The microscope, with all its romance—with all its scientific background and achievement in the fields of medicine, bacteriology, geology, and chemistry—comes into its own again in the realm of textiles.

The scientist and the engineer are once more forced to recognize the age-old paradox that while there may be nothing new under the sun, nature can still offer inexplainable fact after fact, physical and chemical mystery after mystery to keep the art of the textile technologist ever fresh. The chemist is just beginning to solve the enigma of the nature of the chemical structure of the molecule of cellulose—that fundamental building block of all the natural vegetable fibres of commerce. Until more is known of its basic nature and properties, the field of achievement in the development of such radiantly brilliant inventions as rayon will remain barely entered.

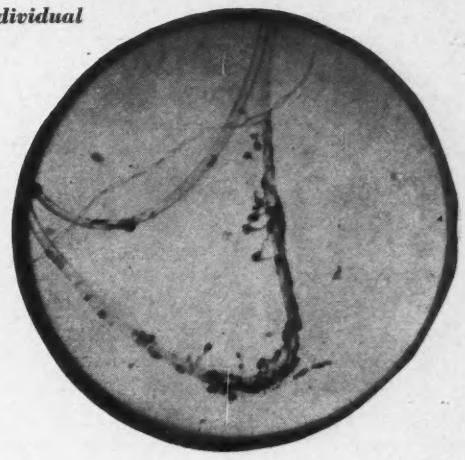
For many years, the physicist has realized that the textile fibre, of whatever sort, possessed almost uncanny physical properties. Can you, for example, imagine a steel column, fabricated of the best material available, and with the finest workmanship, withstanding the action of forces which would flex its tip through a distance many times its diameter for millions of cycles at the rate of sixty per second? Yet the lowly cotton fibre will withstand such treatment as this and exhibit but relatively slight traces of destruction. It is only now being realized, thanks to the microscope, that the cotton fibre is immensely complicated. It is not a simple cell, even though it begins its existence as such, but actually is made up of many concentric layers of spirally laid sub-microscopic bricks, which for want of a better name the physical chemists calls *micelles*. The art of reinforcing columns against mechanical failure, then, is not new to nature. Nor has man yet achieved anything like nature's success here. The microscope shows us much of value and interest to the science of engineering, and at the same time it aids in improving the sheen and softening the handle of milady's sheerest garments.

Relative magnitudes have always had a fascination for the human mind. Either the very



Ramie fibre in polarized light. The fibre is in a position parallel with one of the planes of polarization. Note that the extinction is not complete. The structure of the "cross markings" must be different from that of the body of the fibre.

Fungus growth on individual filaments of rayon.



grandeur of the astronomer's universe, where distances are measured in light years, or the amazingly tiny microcosmos of the searcher after cosmic rays—those mysterious visitors from the borders of the universe, whose size is measured in fractions of a light wave—awes the casual investigator. While it staggers the imagination of the layman, it fascinates the scientist and it bids fair to make the work of the textile research man much easier. To the fungus spore—too small to be distinguished with certainty by the unaided eye—the central channel in a cotton fibre is a concourse rivalling in magnitude that of New York's Grand Central Station to the mortal traveller. That literally thousands of these fungus growths can colonize inside the fibre and on its surface, then, is no miracle. The resulting loss due to mildew in a year amounts to many thousands of dollars, but it is not a necessary evil. Science with its lens systems will find a way to eliminate this waste of money and material, which we now suffer.

That the microscope should play a leading part in such work is only logical. After all it is a means of utilizing the very light which measures our greatest and our smallest magnitudes to serve us further in so enlarging and resolving the detail of minute structures that they may be measured and studied as we please. More than this—fibres are themselves optical systems of no ordinary sort. Together with many chemical crystals they share the property of breaking up and resolving into orderly systems the random wave motion of the light rays passing through them. Microscopes utilizing this peculiar phenomenon, which we call polarization, are of increasing interest for the study of textile problems. Thus light can be made by the fibre to trace on the fibre itself a contour pattern or diagram of the ridges, hills, plains, and valleys forming its curiously fashioned surface. By the very colors produced, the fibre is made to tell its own story of processing, of stress and strain—much as the human countenance, to those who can analyze it, displays the traces of past emotional and physical experiences.

The textile technologist sends out brigades of trained light waves into the no-man's-land of the fibre's internal structure. They reconnoiter, determine the lay of the land, the hills, valleys, and pitfalls of the intra-micellar composition, and return with the information. As in any battle, many are missing in action, but the survivors are able to describe what they have seen. Should they use simple terms the information would be available to enemy as well as friend. Much of their message is, therefore, transmitted in code. Some of the code we are beginning to decipher, some of it remains a mystery, or even appears to furnish contradictory facts. But a little information is better than none at all, and as each message is decoded, a step toward the understanding of the remaining data is made.

Trained light waves, we said. Literally they are fragments of the rainbow—bits of spectra, if you will. Color, therefore, plays an important part in the work with the polarizing microscope. The magic of the direct color photograph finds application here. Through the microscope, to record the colors produced in and on the fibres by changes in contour and in refractive index, natural color photomicrographs are being taken as a permanent record of the work. These transparencies form a colorful history of the war being waged by the scientist on the mysteries of fibre structure.

This structure may sometimes be seen after suitable treatment of the fibre (usually swelling accompanied by high pressures). By the additional employment of the phenomena associated with fluorescence, polarized light, X-ray diffraction, and refractive index determinations, the sub-microscopic constitution of the fibre is studied. The mechanism of moisture and dye absorption is not perfectly understood, but rates of swelling can be measured by taking motion pictures through the microscope at a known number of frames per second and studying the resulting film. It has been computed by workers interested in swelling phenomena that one ounce of fibre presents to the action of vapors in the surrounding air a surface of more than 163,000 square feet. This area is, of course, to

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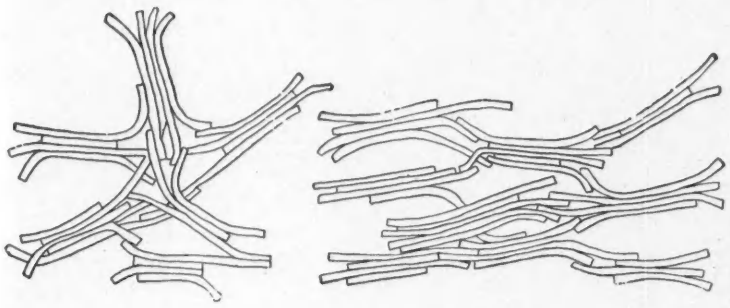

Unoriented and partially oriented structure in a fibre. The condition shown on the right may be due to tension resulting in stretching of the fibre. Moisture penetrates to the spaces between these units.

AN ELECTRICAL PROBLEM IN GEOPHYSICS

A Study of the Earth to Depths of 30 Kilometers

By LOUIS B. SLICHTER
Professor of Geophysics
Massachusetts Institute of Technology

THE deepest drill holes penetrate the earth's crust to a depth of about two miles. Below this level, whatever knowledge we obtain of the state and nature of the rocks must necessarily be deduced by indirect processes. Our ideas about the deep crust are the result of difficult geological studies and inferences. Indeed, it is the job of geology to translate the complex evidence contained in surface rocks and elsewhere into the story of this pear-shaped planet. In the effort to resolve the complexities which beset this ambitious undertaking, an increasing emphasis is being given to the physical and mathematical aspects of the great problem of the earth. Here, as in other branches of science, the precise and powerful mathematical method has been a fruitful one. One may mention, as an example, the revelations concerning the earth's deep interior which have resulted from the study of the propagation of earthquake waves. In utilizing the mathematical method, the geological problem is, as a rule, framed in physical terms, and the physical properties of the materials which enter are obviously of basic import. Unfortunately, however, our information about physical properties of the earth material as it *really* occurs, *in situ*, is quite deficient. Naturally such a deficiency hits the geophysicist in a weak spot,—and the fact that he may find an impressive name assigned to the material is of little comfort. It is the physical properties, not the name, which is wanted.

Technique

The Objective

In the electrical investigations which are here briefly described, the ultimate objective is the determination of the electrical resistivity, and possibly also the dielectric constant, in the upper crust of the earth, to a depth, it is hoped, of about 30 kilometers or more. And why, one may ask, does one care about the electrical resistivity at such depths? In science one cannot hope to predict how or where new information may be used, but experience shows how faulty our scientific extrapolations to unknown ground are apt to be.

We must expect surprises in such explorations, and if we are lucky, the surprises may be of much significance. And if, as often, the explorations yield just about what might have been guessed, we have at least replaced conjecture by definite knowledge.

Several specific geophysical problems may be mentioned in which information about the electrical resistivity may prove helpful. Such data might be combined with knowledge of dynamical properties as deduced from seismology to form valuable evidence in the problem of identifying the rocks at a depth. If one knows five physical properties—say the resistivity and dielectric constant, and the three dynamical ones, the density, the compressibility, and the shear modulus—one is clearly in a much better position to identify a material than if only the last three be known. The question of a more or less sharp transition to a glassy substratum, which under prolonged loads yields like a liquid and serves to lubricate crustal movements above, has long been one of fundamental significance in geology. Conceivably we may some day find important evidence about such a hypothesis through electrical studies. It is well known that the electrical conductivity of glass increases enormously as it melts. Possibly zones of transition to the glassy state may be marked by a high, electrolytic type of conductivity in the crust. Again, in studying certain features of the old mystery of the earth's magnetic field, knowledge of the electrical resistivity of the crust may prove useful. If satisfactory data about electrical properties can be obtained, there seems little doubt that it will find ample application.

In addition to the purely scientific purposes mentioned, attention may be called to similar small-scale applications in electrical prospecting. In both applications the experimental procedures have much in common, and in both the identical interpretation problem may arise. For example, in determining depth to bed rock in foundation problems by the electrical method, the assumption is usually made (as in the large-scale problem) that the strata are horizontal. Under such conditions the problem of determining depth to rock from electrical data is precisely the problem of determining the variation of the electrical conductivity with depth. The level at which the resistivity suddenly increases marks the transition from moist overburden to tight rock. Because of these fundamental similarities, progress in the large-scale scientific problem implies a corresponding progress in the small scale engineering one, and vice versa.

There are two methods by which one may deduce, theoretically speaking, the variation of the electrical resistivity with depth. The first involves the establishment of a direct current flow between distant electrodes on the surface of the earth, and the measurement over a large area of the electrical potentials which are thereby produced. The other involves the creation of an alternating magnetic field by a current flow in a closed horizontal loop of wire, and the systematic measurement of the magnetic vector over large distances at the earth's surface. In both methods, the assumption is made that the crust, at depth, is uniform horizontally (this hypothesis finds some support in the findings of seismology); and in each method a unique determination of the conductivity as a function of depth is theoretically possible.

The present experiment is a preliminary application of the first method.* A current of 10 to 25 amperes was

*The earliest experiments in the measurement of the electrical resistivity of the deep crust are due to C. and M. Schlumberger in France, 1928. See A. I. M. M. E. Tech. Pub. 315, 1930.

passed through the earth between an electrode grounded at Clinton, Mass., and a second, thirty miles away, at West Roxbury. The return circuit was a transmission line provided by the New England Power Association and the Edison Electric Illuminating Company of Boston. The electrical potentials resulting at the earth's surface from the current flow were mapped at intervals of several miles over an area about fifty miles in diameter centering at Clinton. The measurements were referred to an arbitrary reference electrode near Clinton, and the potentials between this reference ground and some hundred other electrodes were measured in millivolts with a potentiometer. Such widespread measurements were made possible by the kindness of the New England Telephone and Telegraph Company, which generously co-operated in the research by providing toll circuits as lead wires to bring the distant potentials to the potentiometer. In order to avoid the influence of polarization electromotive forces and other constant sources of voltage, it is necessary to reverse the source current periodically; hence, the potentiometer leads must also be reversed in synchronism. Such procedure has long been quite usual in the similar small scale mapping involved in electrical prospecting. But the higher currents needed in large scale work and the large self-inductance of the long transmission line bring the commutation and arcing problems into prominence. This difficulty was met by the use of a large (75 mf.) condenser across the circuit breaker to reduce arcing on the break. Also, before re-establishing the circuit, a resistance of several hundred ohms was thrown in series with the condenser, to prevent burning due to a short circuit discharge. In this way, the current was commutated without appreciable sparking. An oscillograph of the commutated current wave is seen in Fig. 1. Here the interval between commutation is about a second, and the current twenty-five amperes. The current curve is not quite flat topped, but drops off slightly due to the slowing of the motor generator as the load comes on. A second curve on this oscillograph shows the potential difference between the stations Holden and Cooleyville, a distance of 50 km. In it a very strong 60 cycle interference is apparent, which masks the smaller component in synchronism with the commutated current. This was, nevertheless, clearly measurable by the potentiometer circuit and long period galvanometers used and was determined to be 304 millivolts. The potential circuit, it will be noticed, is closed only during the time when the current is *steady*. The third line on the record is merely a zero line, displaced to avoid interference with the current curve.

Extraneous Interferences

The chief experimental difficulties in this work arise from interfering voltages induced in the long measuring circuits by fluctuations in the terrestrial magnetic field, by earth currents, and by similar natural, as well as artificial, causes. Because of the industrialization of the present area, street car interference and 60 cycle pick up were especially prominent.

Such effects are all greatly reduced by commutation, but an additional procedure proved very helpful, and

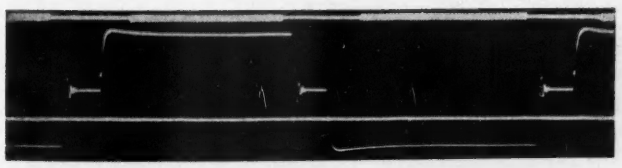

Fig. 1 — Oscillograph of current reversal and of the potential difference between Holden and Cooleyville.

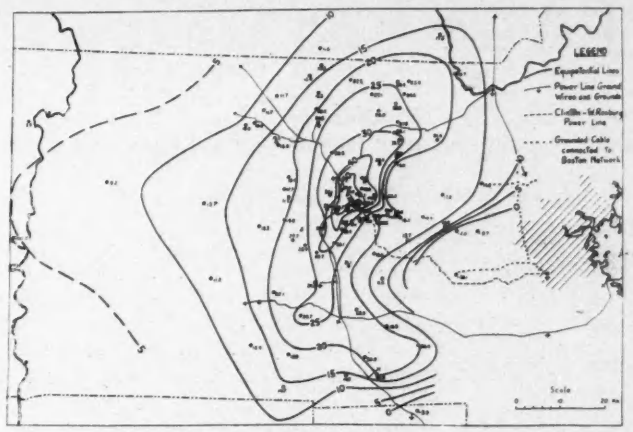

Fig. 2 -- Observed electrical potentials and equipotential curves.

indeed essential. Before commutation of the pick up potentials, an auxiliary balancing potentiometer was introduced in series with the circuit, and the casual potentials were neutralized thereby, by hand; but disregarding, of course, the desired periodic component which reversed approximately every second. In this way, the large random variations of slow period were easily neutralized. The abrupt interferences, however, remained. The resulting potentials were then commutated and measured in the usual way with a potentiometer. Special highly-damped Rawson galvanometers were used in order that the readings might represent the integrated effect of several cycles of commutation. In these galvanometers, the damping is obtained by damping coils quite independent of the main circuit, and it is of noteworthy magnitude. For example, at maximum damping the relaxation time is such that about 24 seconds is required for the needle to return to 1/2.7 of its initial displacement. Ordinarily such extreme damping was not utilized.

The accuracy of the final observations may be improved by taking numerous independent settings and forming the mean. In the present work, either four or six settings were made at each point, but it would be desirable to increase this number if greater precision were needed. In practise one waits for quiet intervals and takes a reading when both the balancing and measuring galvanometers are steady.

The worst interferences were apparently produced by street car operation. At times, changes of the order of a volt were experienced, while an effort was made to keep the readings accurate to a few millivolts. Fortunately, such extreme fluctuation seemed to be absent in the areas more remote from large towns. In any location, however, it is clear that the problem of reducing the effects of meteorological interferences is a vital one.

The Electrical Map

In making the electrical map, a primary network of key stations was utilized, in a manner somewhat analogous to the scheme of first order triangulation in a geodetic survey. These primary stations were tied together by triangulation methods, and the closure errors adjusted by the usual least-squares method. In this way, checks on the accuracy of the mapping were obtained. The drop between Gardner and Clinton was investigated particularly to test the accuracy of the mapping. The distance here involved is 30 km., and the observed drop 2.8 volts. Five polygons were formed between the two points, having five sides in common, and involving six main parallel paths to Gardner. Closure errors in the five triangles

(Continued on page 17)

TELEVISION AT THE PRESENT

By ***HOLLIS S. BAIRD***
Chief Engineer, General Electronics Corporation

TELEVISION is the latest form of electrical communication, which began with telegraphy and was successively followed by telephony, wireless telegraphy, radio telephony, telephoto-facsimile, and talking motion pictures. It has been very difficult to perfect, since wire and radio transmission facilities placed many obstacles in the way, and television does not afford the convenience of celluloid film for image recording. The advent of radio broadcasting in 1922 and its successive developments had made many people optimistic, and when in 1927 a great deal was written and promised about television, people thought that the announcement was merely a natural event and that television receivers for home use would soon be on the market. Such, however, has not been the case, but home television has made sufficient progress to make possible a discussion of its present status and some prophecies that are reasonably safe.

Beginning in 1927 about a dozen laboratories in this country entered upon intensive television researches. The system then employed was mechanical at both the transmitting and receiving terminals and used for scanning either rotating discs or drums with pinholes, lenses, or mirrors. For transmission by radio, several channels, just above the broadcast band in frequency, were assigned for experimental television by the Federal Radio Commission.

After the thrills of the first demonstrations had worn off, the laboratories which had foresight began an investigation of what the public would expect from a television receiver in order that it would have entertainment value and would not be just a novelty. It soon became apparent to them that mechanical forms of scanning when developed to a practical limit of size and price would only give results which were in the novelty class, and they did not provide entertainment, such as the best home motion pictures, with which they should be comparable in quality. Mechanical scanning at the receiver could produce nothing better than images of two heads and shoulders with fair detail or full-length views of dancers and boxers with the motion serving to cover up the lack of detail.

Research men then turned to some phenomenon which could be used for television, which was not mechanical, which had no appreciable inertia, and which would not involve large and impractical apparatus as the picture quality was improved. In 1911 an Englishman, named A. Campbell Swinton, had suggested the use of cathode rays for scanning in television at both the transmitting and receiving ends; this plan involved no moving mechanical parts. At that time cathode rays had been used for inertialess oscillographs, and any television receiver whether it is electrical or mechanical is, technically speaking, an oscillograph.

Very little was done to develop this idea until about 1930, when all hope of developing mechanical television to a par with motion pictures was abandoned. At that time the laboratories of the Shortwave and Television Corporation, a division of General Electronics Corporation; the RCA Victor Company; and the Philco Radio Corporation began a concentrated research on the application of cathode rays to television. From this time fairly rapid progress was made in the use of the cathode-ray oscillograph tube as a television receiver, since it inherently had many of the features of an ideal television receiving device. The application of cathode rays at the transmitter proved to be a more difficult problem. One of the big drawbacks of mechanical transmission had been the great amount of illumination necessary upon the subject or scene, it being much greater than that needed in taking motion pictures, if good-quality pictures were to be transmitted. Most forms of cathode-ray transmitters that were suggested made no increase in efficiency. One theoretical manner of increasing the output of the cathode-ray transmitter, which was suggested by Dr. V. K. Zworykin of the RCA Victor Company, was to form the image to be transmitted on a plate which was coated with separate globules of photoelectric material. The plate was an insulator so that the globules charged up positively due to the emission of electrons, the charge depending upon the light intensity of the particular spot of the image. This meant that the light was effective upon the photoelectric surface from one scanning period to the next, or approximately one twentieth of a second, while previous methods had depended upon the light point from the image travelling across the photosensitive surface, or other similar action, where the time of exposure was anywhere from one hundred-thousandth of a second to one millionth of a second, the shorter time being employed for best pictures. During these short periods sufficient electrons would not flow from the photoelectric surface to give a useful signal output.

The longer period of one twentieth of a second would provide plenty of time for sufficient energy to accumulate from the image. Difficulty, however, was had in putting this principle into practice in getting the charge from the globules. An astronomer, Dr. F. C. Henroteau, formerly of the Dominion Observatory, discovered some years previously that a very effective means of getting the energy from these charges was to scan the photoelectric surface, upon which the image was produced, with a steady beam of light or electrons in a high vacuum. More energy, of course, would be in this steady beam than was needed to neutralize the charge, but this excess was thrown off from the surface. The reduction to practice of these principles has produced a very practical television camera, which will give good outputs from either outdoor or indoor scenes with adequate detail. This camera has been called the Super Eye by the General Electronics Corporation, who are operating under the Henroteau patents, and the Iconoscope by the RCA Victor Company. It seems to be the missing link in television and will have many other applications in years to come, for it is sensitive to infra-red and ultra-violet light as well as the visible spectrum.

A description of the operation of the complete television system is as follows: The scene to be transmitted is focussed on the photoelectric plate in the television camera. This plate is, of course, in a vacuum tube. If the scene is indoors, it will be floodlighted, or if outdoors, the daylight is sufficient. The light from the scene falling on the photoelectric globules causes them to emit electrons in proportion to the intensity, and since the globules are on an insulator with a metal plate on the

back each globule will become positively charged. The beam of electrons from the cathode-ray gun is scanning the plate from side to side and top to bottom and does this every twenty-fourth of a second. The electrons which have been thrown off of the globules by the action of the light are replaced by this beam, and the resulting pulse is the signal which is amplified and either fed to a cathode-ray receiving tube over a wire or broadcast over the radio channel. At the end of each scanning line a synchronizing pulse is put in the signal at the transmitter which causes the cathode-ray beam at the receiver to be in exact synchronism with the transmitter. The television signal after being amplified and rectified at the radio receiver is applied to the control element of the cathode ray receiving tube. This cathode-ray beam scans a screen which becomes fluorescent under the bombardment of electrons. The number of electrons in this beam is varied in exact proportion to the shading of the original scene. A phenomenon known as persistence of vision makes the screen appear as a complete picture rather than as a series of individual spots of varying brightness.

It is a recognized fact that the greater the picture detail to be transmitted, the greater must be the band of frequencies employed to transmit the picture. This means that high-quality cathode-ray images will require a higher band of frequencies than used in mechanical systems of poor detail. For what are known as 240 line pictures the band extends from 24 to over 1,000,000 cycles, and such a wide band could not be placed upon the radio channels assigned to mechanical television transmissions.

In order to find radio frequencies which could be modulated with the wide band and still give good local coverage, it was necessary to go below ten meters (to ultra-high-frequencies). These frequencies from 42 to 86 megacycles have been assigned exclusively to television with the exception of those from 56 to 60 megacycles. On frequencies greater than approximately 35 megacycles the radio waves do not travel beyond the optical horizon and also are not sufficiently reflected by the Heaviside Layer to return to the earth for distant reception. This means that the coverage of these television stations will depend upon the height of both the receiving and transmitting antennas above sea level, and also to some extent on the intervening objects, which can cause shadows or points of weak or no reception. At practical heights of antenna location the maximum range of the transmitter will average forty miles.

Since no sky wave is reflected to cause distance interference, the same frequencies can be used with only a separation of approximately one hundred miles between the transmitters. The sound accompaniment for the television program is also transmitted on the ultra-high frequencies, and much higher quality reception is possible, as the channel width is sufficient for high-grade transmission of all audio frequencies, a feature which is not possible on the present allocation of sound stations in the broadcast band.

It is not possible to transmit these high-grade television images over present wire circuits, so that programs which are to be relayed from one point to another for rebroadcasting must be sent over radio channels. These radio transmissions may be directional from one relay station to another, or they may be broadcast non-directionally if it is also desired to reach the population of the surrounding area. Wire circuits can be built for these pictures, but the cost at present is so great that it appears that an indefinite time will pass before they will be used. A transmission line satisfactory for television costs about twenty times as much as one for regular broadcast transmission.

General Electronics Corporation

A photograph of an actual television picture received, using 240 line transmission. If action were present, as is usually the case, the image would seem better in detail, since the eye would be following the motion rather than scrutinizing the quality.

The cathode-ray-television receiver at present has been built around two types of receiving tubes. The first and earliest type uses a large tube with a screen nine inches in diameter on which the image is produced, and no external magnification is used, the picture being about 5x6 inches. This type is very satisfactory for laboratory use but probably will not be sold to the public since large vacuum tubes (such as the cathode-ray tube referred to) do not lend themselves to mass production, a fact which keeps the price high. For a complete television receiver there must be in addition to the cathode-ray tube, two ultra-high-frequency receivers (for sound and vision), power packs, and sweep circuits for the scanning tube. A later type of receiver which is being brought to a point of perfection uses a small cathode-ray tube which produces a small, but bright picture, that is projected upon a screen a foot or two square. These small tubes can be manufactured almost as cheaply as receiving power tubes, but, of course, the same additional parts as mentioned above are needed to make a complete receiver.

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EDITORIALS

ENGINEERING FOR HUMANITY

THE passage of fifty years has placed the engineer and scientist in the position of the greatest benefactor of society. In earning this name, the technologists have brought forth literally thousands of devices which serve to uplift humanity in general; but in all this progress, little thought has been given to those few who lose by these developments.

Let us take for an example, the development of the air brake for railway trains. With the adoption of this invention we find that railroad accidents are decreased immensely, transportation is quickened, and both freight and passenger rates reduced. But to turn to the other side of the picture—many brakemen find themselves out of work, since it is possible for the engineer to perform more effectively from his place in the cab the work of many men. Not one sensible person will condemn this, or other inventions, on the ground that it works hardship on a few.

But this few is really large in number! What has the technologist done to counteract this evil? The time has come when the engineer and the scientist should support a measure which will aid in permanently reducing unemployment.

A nation-wide pension system which will provide for the retirement of all workers after they have reached a certain age and have worked a certain minimum number of years seems to be a plausible solution to the problem. A plan which would cover the whole country in *every* industry should be the aim. The money for this pension could be obtained by small payments deducted from the workers' salaries and small sums donated by the employers. A large Canadian railway has provided a similar pension for a number of years, and that system has now become practically self-supporting, requiring only very small contributions from the employees. If a man transferred from one industry to another, he should lose none of that money which had accumulated during his period of employment. Should he retire from work before the time for his pension, the amount which had been applied from his salary, plus interest, would be returned.

An outstanding feature of this plan is that it would enable a man (or woman) to retire after reaching an age of fifty-five or sixty with an income comparable to that which he was earning before retirement. But above all, it would tend to relieve unemployment, which can be blamed upon the high state of mechanization existing, by preventing the accumulation of multitudes of aged men in industry. It would give the young man an opportunity to find employment; it would give a man something to work for; and it would make all working persons inde-

pendent after reaching a certain age. This last benefit would automatically relieve the work of many welfare agencies and would relieve children of the burden of support of their parents.

Obviously, it is not possible to put this idea into operation at once; it is necessary to work out some plan for those who are nearing the retirement age or have already passed it, because the financial backing has not been accumulating over the years. A bond issue floated by the Federal Government might be used to obtain the necessary backing. There is, however, no reason why the pension plan cannot be immediately initiated on such a basis as to benefit the younger workers in the ensuing years.

For the technologist, in particular, to support and promote such a move would demonstrate in full the realization that he occupies a key position in this age of mechanization, and that he is willing to carry out the duties imparted. Truly fitting would be the title—Human Engineer.

VINTON K. ULRICH '35.

ENFORCED HONESTY

THERE are many manufacturers who are proud of the quality of their products and seek to give the customer more than full value. They realize that it is the best policy. Others, fortunately in the minority, desire nothing but the customer's money. Naturally, this minority seriously handicaps the progress of business toward higher standards, a progress which at all times is discouragingly slow. The year 1906 marked the end of a long fight for regulation and protection with the passage of the famous Pure Food and Drug Act. That law, although adequate at the time, stands in need of revision to suit present-day life.

One yawning loophole leaves advertising relatively free and unconfined. Although the labels on the product are strictly regulated, all kinds of extravagant claims can be made in magazines, on billboards, and on the radio. Take, for example, the nationally-advertised mouthwashes, toothpastes, and tobaccos. Their labels are innocuous, made so by the government, but listen to the unmitigated "blurb" that accompanies their radio programs or read their claims in outstanding weekly magazines and notice the difference.

In the field of cosmetics, something relatively new since 1906, abuses have been well-nigh uncontrollable. The Federal Food and Drug Administration in analyzing the various hairdyes, hairtonics, eyelash beautifiers, and the like has found a surprising number containing ingredients harmful to the skin.

There is also the need for a legal standard for food products not covered by the law provided for canned products. There are ever so many ways for big concerns to dupe the public. Ice cream, for instance, may contain anywhere from 4 to 18 per cent. butterfat and have the same bulk. Some of it is just so much well-thrashed atmosphere. Bread spreads may vary in fruit-content from 20 to 45 per cent., the rest being water, pectin, and acids. Two large jars may appear to be about the same size, yet one through the use of thick glass and raised bottoms may contain only two-thirds as much.

Obviously, the housewife cannot run researches to see where she can get the best value, and the honest manufacturer suffers accordingly. To remedy the situation a Revised Federal Food and Drug Act has been prepared and is now before Congress. Reliable manufacturers will find it to their advantage to work for its passage to the fullest extent of their powers.

A GOAL FOR THE N. I. R. A.

OUTSTANDING among the objectives of the National Industrial Recovery Act has been a desire to abolish unemployment. Millions have been spent, and millions will be spent in this movement which is accomplishing wonders. However, after this artificial stimulant has been spent, what permanent aid shall we have acquired? The younger generation will be left with some public works projects, but will also inherit a per capita cost of government which will redden the annuals so greatly that the assets will look insignificant. The per capita cost, in 1913, was $30.24; in 1929, $107.37; since then the national government has gone more deeply into debt, while the state and local governments, which are a large factor in these debt analyses, have increased their debts tremendously.

There is no doubt that the younger generation will have a burden to pay off, and undoubtedly it would like something to show for this debt. One of the better things which this money could buy is a higher plane of living. If the N. I. R. A. is going to leave a burden, it should also leave an asset. Such an asset would be a change in our antiquated economic system. The N. I. R. A. seems to have favored a policy which would hamper the expansion and use of more efficient machinery, for by such means it is possible to increase employment. The administration, however, appears to have forgotten that machinery is the best means which we have of decreasing the burden of the laborer and raising the plane of living. A favorable balance between wage, hours, and production depends upon machinery. Production may be kept constant and hours decreased if more machinery is used.

Behind any such move to revise the economic order should be the engineer, who is primarily an efficiency expert, not in the old sense typified by the efficiency man who rose from his coffin and announced that, if they put rollers under his coffin, they could save five pallbearers, but in a new sense typified by the man who is not actuated by a desire to cut costs in order to increase material profit, but is, on the other hand, stimulated by a desire to cut hours and increase the machine efficiency. In other words the new efficiency man will be an engineer who is striving to make men again the masters of the machine.

The engineer should see the N. I. R. A. as a medium through which to accomplish results which *must* come, and which few desire to see come through Communism. He should fight to see that the N. I. R. A. encompass in a list of its goals a new higher plane of living. Thusly, the present generation has it within its power to give the next generation something for its money.

OUR ALUMNI

IT is with pleasure that the Managing Board finds itself in a position to distribute this issue of THE TECH ENGINEERING NEWS to those of the alumni who have found it possible to attend the Alumni Banquet, the purpose of which is to assemble the alumni as a social group and thus improve their congeniality, their loyalty to their alma mater, and the *esprit de corps* of the alumni body. Moreover, the banquet is being held this year in Walker Memorial to bring the alumni closer to the undergraduate student and his life. To further this last idea it has been arranged that all student activity offices will be open for inspection before the dinner. It is hoped that the alumni will take advantage of this opportunity to visit these offices and see how they have changed since their day.

ENGINEERING DIGEST

GRAPHITE ANODES

CARBON for use as the anode in vacuum tubes for use in radio has many advantages. It has greater heat emission properties than tungsten, tantalum, or molybdenum, the metals used in making anodes at present. High conductivity and high temperature point of vaporization, coupled with its adaptability to close machining, and a homogeneous structure which does away with strains and warping during manufacture, are all advantageous properties of carbon when used in anode construction.

For several years experiments on the use of carbon for this purpose have been made, but there have been the following difficulties which could not be overcome until recently:

(1.) The fact that all machine carbon has a certain amount of amorphous carbon left on its surface, and this flakes off, depositing itself on the filament, thus retarding emission, or else providing a low resistance path across insulators.

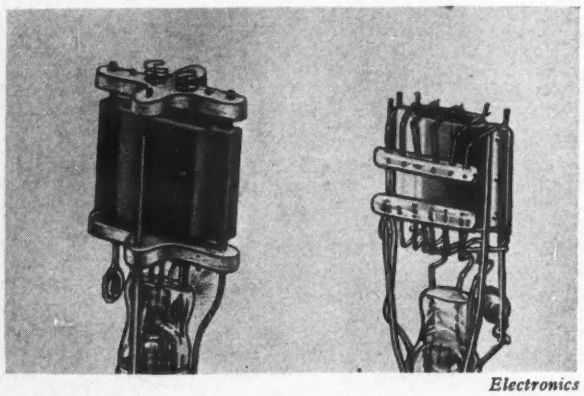
(2). The liberation of gases from the anode of a transmitting tube, because of the hydrocarbons necessary in binding the carbon together, which break down and form gases that shorten the life of a tube greatly, and prevent its use at high powers.

(3.) Difficulty in machining with precision, large pieces of carbon for high power tubes.

Of these, the most important are the first two mentioned, and it has only been recently that a process has been perfected under the leadership of V. O. Allen, which removes all amorphous carbon from the finished anode and also breaks down the binder and converts the whole carbon mass to graphite.

With this step accomplished, a method of machining the pieces of graphite with a tolerance of only 0.001 inch was developed. Because of the accuracy of the machining, a one piece construction is used, which obviated the difficulty of riveting two or more pieces together.

These graphite anodes are held in place with respect to the other elements of the tube, by the "I" beam type of construction, wherever possible. These "I" beams give a maximum of mechanical strength with a minimum of metal to be degasified.



Electronics

Note the rugged construction of the graphite anode appearing at the left. The conventional anode is at the right.

As an illustration of how a graphite anode increases emission for a given size of anode surface, one made of graphite will dissipate seventy watts while the same size when made of molybdenum will dissipate only sixteen watts; if tantalum were used the maximum dissipation would be only fourteen watts.

Since a graphite anode has a higher heat emission than any substance yet used, the internal structure of the tube is kept much cooler and the grid and shield grid are maintained at a temperature several degrees cooler, thus cutting down the harmful secondary emission and preventing to a large extent the liberation of gases.

Further uses of this specially treated graphite are becoming apparent with increased experience. One of the most important uses in the future is for the grid structure in water-cooled tubes of large size where a very intense heat has to be resisted by the grid. High-frequency tubes can make good use of graphite as an anode because of the tungsten filaments employed and the attendant heat evolved. (*Electronics,* vol. 6, no. 12, December, 1933, pp. 338-339, 2 figs.)—R. Y. J.

STREAMLINED AUTO LAMPS

MODERN trends in automobile streamlining find another advocate in a new prefocused lamp that permits smaller headlights and contributes to better styling of car fronts.

Streamlining the headlight means reflectors of smaller diameter. In order to obtain a desirable reflector efficiency with these smaller designs, it has been necessary to reduce their focal length to $1\frac{1}{8}$ inches, which is from $\frac{1}{8}$ to $\frac{1}{4}$ inches shorter than in the conventional type reflectors. Consequently, the light center had to be positioned more accurately so as to preserve light control, hence the new prefocusing base.

In Westinghouse Mazda headlight lamps, the new prefocusing base consists of a collar rigidly fastened to the base. Three slots unequally spaced around this collar are engaged by three small pins projecting through the flat section at the apex of the headlight reflector. Springs behind the reflector exert a pressure on these pins to hold the bulb firmly in position. Since the pins and slots are spaced unequally, the lamp can only be inserted when they match in the correct position. The lamp is inserted the same way as the standard bayonet base bulb, namely, by pushing in and rotating clockwise to engage the pins in the slot openings.

Where, in the past, automobile headlights were positioned to an accuracy of only 4/100 inches, the new lamp is held within 1/100 of an inch. The filaments are mounted in the lamp with the utmost of accuracy in relation to the collar. During manufacture the filament position in the lamp must pass the focal gauge test in which it is projected onto a screen that magnifies it 20 times.

The new prefocused headlight lamps, in making possible smaller auto headlamps without loss of lighting efficiency, are expected to contribute largely to progress of streamlining since it is the fronts of cars which must perhaps undergo the greatest transformation in style changes. (*Westinghouse Technical Press Service,* report no. A-62586, 2 figs.)

EFFECTIVE CAMOUFLAGE

THE history of camouflage goes back to earliest man. Animals, fishes, birds, and insects are all camouflaged to a certain extent. In more recent times, Napoleon made skillful use of camouflage, while his great opponent, the Duke of Wellington, used it against the French with telling effect. Not until quite recently, however, has camouflage reached a very marked degree of perfection, mainly because so few soldiers have used it. Even today it is disregarded to a large extent; popular opinion deems camouflage a cowardly weapon. Nevertheless, the purpose of war is to kill without being killed, and neither a stout heart nor a strong chest will turn aside bullets that may well be avoided by using camouflage. The value of camouflage was strikingly illustrated in the Boer War, where the Boers, with inferior forces, were remarkably successful in defeating the British.

Paint is popularly associated with camouflaging, but paint is the worst possible device for such a purpose Paint is esentially an advertiser. It attracts attention and thus defeats its purpose. Norman Wilkinson, who painted war-time ships in so dazzling a fashion, said that the painting was to deceive the enemy as to the direction of the ships' motion and was not for concealment.

By the use of brushwood spread in a line, the shadow of the interior of a trench may be simulated so well that airplane observers are deceived into believing that a trench actually exists. In muddy areas the incongruous shiny buttons and helmets of the soldiers, as well as the uniforms themselves, should be plastered with mud. The familiar outline of the body may be destroyed by clothing the soldier in burlap material to which bags of straw are attached. If trenches are dug so as to follow the folds of the hills, they are rendered inconspicuous and can be made completely invisible by making the top of the trench, front and back, look like the surrounding ground. If one man walks diagonally across the furrows of a plowed field, his tracks are plainly visible from the air, but a thousand men might leave no visible tracks if they followed the furrows in crossing the field. While Dr. Alister MacKenzie was experimenting with dummy trenches during the World War, the British Headquarters made him stop his work because they were unable to correctly interpret air photographs of their own fortifications, so real did the dummy trenches appear. The Germans must have been deceived fully as much, but the ignorance of Headquarters did not see that the British could readily rectify their air maps while the Germans could not (*Military Engineer*, vol. 26, no. 145, January-February, 1934, pp 43-46.)—P W A

Military Engineer

Effective camouflaging as shown above proves its value in making objects practically invisible. It would be even more difficult to see the camouflaged man if the uniformed figure were absent.

NEW PAPER FROM OLD

NUMEROUS processes for the liberation and removal of the carbon black pigment of printing ink from paper are known and some paper-making plants have for a long time secured a large portion of their fibrous raw materials from paper stock recovered from discarded books, periodicals, and other publications printed on paper composed of cellulose fibres free from lignin. However, most printed paper contains groundwood pulp, the fibres of which have not been chemically purified to remove the lignin constituent of the ligno-cellulose. Our newspapers and telephone directories are printed on such paper.

Papers containing groundwood pulp are desirable, on account of their excellent printing qualities, for use where permanency of record is not of importance but accurate presentation of the message is necessary. In the past the objection has been that the reprocessed paper has not been sufficiently bright in color to permit its substitution for virgin stock. The difficulty is encountered in the removal of the printing ink from the paper. The detergents used to loosen the ink discolor the ligno-cellulose fibres, and bleaching agents such as calcium hypochlorite when used to bleach any discoloration react with the lignin to form a brown chloride. Then, too, the groundwood fibres contain such a large portion of fine debris that it is difficult to remove the particles of carbon black used for the pigment of the ink.

It was suggested that a substitute be found for the chemically inert carbon black pigment universally used in black printing ink. The Combined Locks Paper Company undertook the problem. First they determined where they could obtain an adequate supply of printed paper to maintain a commercially operated plant. Telephone companies distributing new books semi-annually and collecting the old books provided the best source of constant supply. With the aid of the Hilton Davis Co., printing ink specialists, a dischargeable pigment composed of the iron lake of haematein has been developed. Ink made from this base compares favorably with carbon ink in printing half-tones, covering power, color, and wear on printing plates. It meets the requirements of both the publisher and the printer. It is capable of being either bleached with hypochlorite solutions or sulfurous acid.

The Combined Locks Paper Company has worked out the details for recovering paper printed with this ink by a process using sulfurous acid. Since the publisher can find a market for his old publications if he uses this new ink it was not a difficult task to establish the position of the iron base ink. In the plant of the Combined Locks Paper Company old telephone directories are the main source of printed matter, for they are easy to store. Its present productive capacity is over 60 tons of recovered stock per day. (*Chemical and Metallurgical Engineering*, vol. 40. no. 12, December, 1933, pp. 634-637, 5 figs.)—N. G. B.

ARC ARRESTER

WITHOUT introducing mechanical devices to suppress the arc it is possible to speed a. c. arc extinctions with a simple, rugged, single-break type of contactor by inclusion of an arc arrester. This recent development for

(Continued on page 16)

ENGINEERING DIGEST

(Continued from page 15)

mounting on the base of a contactor or linestarter involves a small unit consisting of a small capacitor and resistor connected across the poles on the load side of the contacting device.

Effectiveness of the development is said to be startling. Oscillograms show less than one-half cycle arcing with the arc arrester as against a persistence of five to eight half cycles under otherwise identical conditions without it. This example involved tests at 550 volts, 60 cycles with a 7½ h. p. motor, rotor locked, as load.

In practical installations but one unit is required for a three-phase contactor and relief is afforded not only for the contactor or linestarter upon which it is mounted, but also for any operating switch, fuse, or other rupturing device connected ahead of the contactor. On three-phase reversing service only one "arc arrester" is required for it acts with equal effectiveness to relieve either the forward or reversing contactor. (*Westinghouse Technical Press Service,* report no. A-62554.)

TELEVISION AT THE PRESENT

(Continued from page 11)

The production of television programs will be far more expensive than the present radio programs since costumes and scenery are necessary. Whether advertisers will bear this expense is still a matter of doubt. It does not seem possible that television programs on an eighteen hour a day basis, as radio is now conducted, will come very soon. Where radio reception can form the background for the day's activities, from housework in the morning to bridge and reading in the evening, television programs will require the undivided attention of the observer and for this reason must have plenty of variety to hold interest.

Where the ears will accommodate themselves to all sorts of distortion in sound reception, the eye is much more critical, and, therefore, the television receivers cannot degenerate to the point that the average radio receivers have in recent years. In addition the wider channels available for the sound part of the television program will allow high-quality reception that is now obtainable only from the original source and electrical recordings but not over broadcasting channels.

In summarizing it seems safe to say that within two years television receivers of the cathode-ray type will be available to the public at a reasonable price, and that many of the larger broadcasting stations will have installed transmitters which will provide television program service of entertainment value.

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An Electrical Problem in Geophysics

(Continued from page 9)

before adjustment were as follows: 30, 4, 28, —34, and —13 millivolts; thus the mean absolute closure error is 22 millivolts. After a least squares adjustment, the six different paths yielded results for the Clinton-Gardner drop as follows: 2.802, 2.804, 2.805, 2.805, 2.805, and 2.806 volts.

These data show a surprising degree of internal self-consistency, but the agreement here is undoubtedly somewhat fortuitous, in the light of the magnitude of the closure errors before adjustment. In most cases, the internal consistency was of the order of 10 to 20 millivolts, or about 1 to 2 per cent., after adjustment.

The mapping was done after midnight and on Sundays, when the circuits were available, and incidentally when industrial disturbance was a minimum. By the methods outlined, a satisfactory electrical map was obtained in an area between Woonsocket, R. I., on the south, Nashua, New Hampshire, on the north, Cooleyville (about 12 miles east of the Connecticut river), to the west and Concord, Mass., to the east. In addition, points at Springfield and Greenfield were taken, and the most distant observation at Pittsfield, 80 miles away The map is shown in figure 2. Points at which observations were taken are shown in black, and the numerals opposite them represent potentials above Pittsfield (off the map) in millivolts per ampere of source current. Since actual currents were of the order 10 to 25 amperes, these figures approximate the observed millivolts if multiplied by 10. The equipotential lines are shown heavy, and in general have a north-east, south-west trend, in harmony with the regional geologic structure. Apparently, also, some subordinate geological features find reflection in the map. The most westerly equipotential line, shown dotted, is to be given little weight, for it is defined by observations at four points only, and these were only weakly tied in with the remaining map. However, any detailed discussion of the map and the results must be omitted in this bried account. A few remarks of a summarizing nature must suffice. Although commercial interference in this area was especially severe, it was possible to obtain a map in which the closure errors fell within moderate limits. The power used (six kilowatts) is relatively small, and it appears feasible to commutate materially larger currents without undue expense. The present experiments indicate that measurements of this type may be carried out on a larger scale, which implies that the depths of exploration will be correspondingly increased. But the New England area is unsuited for actual determinations of the resistivity function at depth. In so far as size is concerned, the map is large enough to yield information on the resistivity down to a depth of about 8 kilometers, but the highly conducting ocean on the one hand and the great folds of the Appalachian system on the other spoil the symmetry demanded in the theoretical problem. One must look to areas like the flat mid-continental country for the best obtainable conditions for measuring the electrical resistivity of the deep crust.

Acknowledgments

The type of investigation described has necessarily been built around the power and telephone line facilities of commercial companies. The contributions of the New England Power Association, of the Edison Electric Illuminating Company of Boston, and of the New England Telephone and Telegraph Company have been of a very essential type and have involved inconvenience as well as expense to them. It is a pleasure to acknowledge our indebtedness to these companies. The interest and spirit of co-operation of their operating and engineering staffs were of great aid in meeting the practical problems which arose and a source of personal satisfaction to the author.

The writer also wishes to express appreciation for the co-operation and interest of members of the departments of electrical engineering, physics, and geology at M. I. T., and for the able help of his research assistant, Mr. D. G. Fink.

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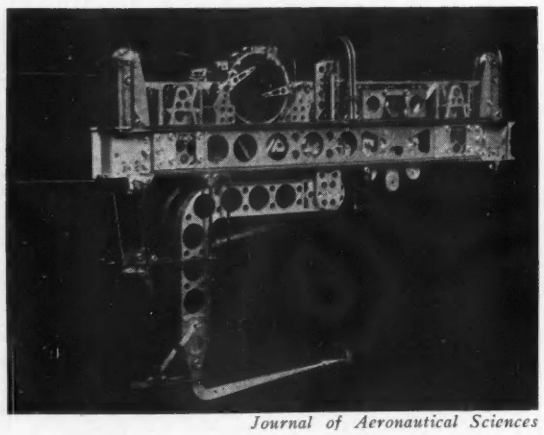
RESEARCH IN REVIEW

COURSE XVI — Aeronautical Engineering

PROFESSORS Richard H. Smith and J. Van H. Whipple have just completed a report on air force measurements on bodies moving through still air. Their apparatus, consisting partly of two long steel wires, was set up in the steam laboratory where runs were made, usually at night because then the air was much stiller. It was important that the air be perfectly quiet since turbulence alters the sensitive flow regime around a moving body as the burble attitude, or the critical bluntness of a body at which the flow breaks away from the surface, is approached. In such critical cases the measurement of the pressural reactions on a body in a wind tunnel are either of doubtful value or are distinctly deceptive and cannot be safely used as the basis for the study of important dependent phenomena such as spinning or lateral control at the stalling point.

The method agreed upon for the preliminary tests was to move the models through the still air of the large room in a straight line with as nearly a uniform velocity as possible and to measure the speed, the model lift, and the drag simultaneously. The models were mounted on a suitable carriage running on two long and very taut wires, slightly inclined. The carriage was then launched at nearly terminal velocity, allowed to coast down the wires, and then was brought to rest by a suitable retarding gear. The absolute speed was measured with an electric tape chronograph, while the lift and drag forces were recorded as continuous records on a smoked glass chart borne and rotated by the carriage. The drag mechanism was in dynamic balance and quite independent of the lift mechanism. Both were oriented accurately to each other and to the wires.

The completed instrument was constructed from rolled duralumin shapes and high strength aluminum alloy castings. It was very light, weighing only 14.5 pounds with housing, yet it was sufficiently rugged and stiff to maintain its internal alignments and adjustments in normal usage and, in the case of an emergency, to withstand a force of 200 pounds, corresponding to a deceleration of 15 or 18g., applied at the bow. All working parts were fully shielded from the air by a transparent celluloid housing, streamlined and proportioned to render the interference effects very small.



Journal of Aeronautical Sciences

The travelling carriage ready for use.

The practical speed range of the traveling balance was from 5 to 40 feet per second and was controlled by adjusting the launching speed and the wire slope. No difficulty was found in adjusting the speed so that it was uniform within 0.1 feet per second over the central span region. The energy for launching was supplied by a falling 500 pound weight, which gave a launching acceleration of about 4g., thus yielding a speed of about 40 feet per second when the catapult travels its maximum distance.

The precision of the drag readings under the conditions of static calibration were ± 1 gram for drags under 50 grams, and ± 2 grams for drags up to 500 grams. The lift readings are reliable to ± 2 grams for loads under 100 grams, ± 3 grams for loads between 100 and 500 grams, and ± 5 grams for loads between 500 and 1500 grams.

COURSE V — Chemistry

PROFESSOR WALTER C. SCHUMB is studying the influence of the electrodeless discharge upon chemical changes occurring in gases at low pressures; in particular, the syntheses of ammonia and of carbon dioxide have been investigated, attention being paid to the effect of the wall surface, and of changing experimental conditions, upon the steady state attained in the resulting gas mixtures. Further light is being thrown upon the causes of the known lack of applicability of the so-called law of "mass action" to these and other reactions in electrical discharges.

In co-operation with Professor Guillemin of the Department of Physics a study of the effect upon chemical changes of supersonic vibrations is under way, and a magnetostriction apparatus has been assembled to serve as the source of the vibrational energy.

The thermal decomposition of thionyl chloride is being investigated quantitatively at different temperatures. From the results to be obtained in this work it is anticipated that an improved method of synthesis of this valuable reagent may be developed.

With the aid of Professor Arthur C. Hardy's recording color analyzer, and the new polarimeter of the Research Laboratory of Organic Chemistry, a comparative series of measurements of the absorption and of the rotation shown by optically active compounds of the rare earth and other elements is being made. The data obtained are being applied to a further study of the Cotton effect.

In the ill-defined borderland between the organic and inorganic fields lies the problem of the preparation of organo-metallic compounds. Those of indium, few of which have been isolated up to the present time, are being investigated.

Dr. Ralph C. Young is continuing his study of the lower valences shown by the elements of Group IVa of the Periodic Table, with especial attention to the element thorium, which up to the present has successfully resisted all attempts to induce it to assume a valence less than four. The elucidation of the striking anomaly shown by thorium in this respect, in comparison with the elements zirconium and titanium, is the primary objective in this work.

Professor Arthur A. Blanchard and Dr. Manly M. Windsor are continuing the study of the preparation of

metal carbonyls and related compounds, such as the nitrosyl-carbonyls. The mechanism of their formation at ordinary temperatures and pressures, and the connection between structure and physical properties, such as volatility, are being investigated in particular.

Dr. George H. Cady is engaged in the study of the reaction of fluorine with various substances, such as the alkali hydroxides and water, with the aim of obtaining further information concerning the possible existence of salts of the oxyacids of fluorine. The system HF—KF also is being fully studied over a wide range of temperature.

Dr. R. P. Seward continues a series of investigations upon the solubility relationships in non-aqueous media, with the aim of further testing the validity of the Debye-Hückle theory and the various extensions thereof.

Dr. E. Lee Gamble has under way the preparation and study of the properties of boron compounds, other than the hydrides, possessing a chain structure. The object of this work is to gain further knowledge in a comparative way of the strength of the boron-boron linkage in comparison with the analogous bonding of silicon and of carbon atoms.

In association with the staff of the analytical division and of this laboratory, Dr. Stephen G. Simpson has been conducting a thorough examination of the methods for the determination of zirconium in ores and in alloys, and has demonstrated the advantages of a combination of the phosphate and the selenious acid methods for this purpose, both in time and in accuracy.

Romance with the Microscope

(Continued from page 7)

a large extent internal and reached by penetration of the outer layers of the fibre. X-ray analysis indicates strongly that moisture, for example, is held between the micelles and causes no change in their internal structure. Its presence under these conditions naturally causes separation of these units and results in a decided swelling of the fibre. From purely practical considerations, such fundamental investigations are of immense importance as explaining the mechanism of shrinkage in textiles. And while it at first requires a certain stretching of the imagination to get the connection between the X-ray tube in the scientific laboratory and the shirt in the laundry, there is a definite one. The felting of fibres, used for many thousands of years by our Asiatic forebears to provide clothing and shelter, is due in certain of its phases to the separation of the micelles of the fibres and resultant changes in physical properties. To the modern girl the same action in reverse is used to provide her with that misnamed "permanent" wave.

With increasing knowledge of fibre constitution the physiologist becomes better able to picture the real mechanism of animal fibre growth. Much interesting data is already available. It is not complete and in its present imperfect state is tantalizing. For example, it has been rather conclusively shown that the occurrence of the waviness existing in wool is a periodic function of time, and is independent of the health of the sheep, its diet, or its environment. Whether the fibre is coarse or fine, long or short, if it grew in a definite number of days, it will possess the same number of waves as another fibre grown during the same time. What is the action of the skin follicle? Nobody yet knows. Thus physiologist, biologist, botanist, physicist, and chemist join hands in the exploration of the wonderland of textile.

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Municipal Police Communications

(Continued from page 5)

The conventional police radio system is a one-way system. The dispatcher does not know positively that his message has been received by the designated car until the officer in charge calls him by telephone. Many police departments have desired two-way radio so as to be able to check instantly the reception of orders by a particular car. Two-way communication has not been generally realized, however, due to a shortage of frequency assignments. Shortly after the submission of the Technology report to Boston in May, 1932, two-way ultra-short-wave radio equipment became available on an experimental basis. It appeared to possess certain advantages, principally in that the area covered was considerably restricted, permitting assignment of one frequency in a large number of localities, and because of the fact that the additional frequency assignments required for two-way working were available in the ultra-short-wave band.

During 1933 several cities received frequency assignments and installed ultra-short-wave radio transmitters and receivers at their police headquarters and in patrol cars. Some of these used variable sets requiring the operation of a push button to change from the receiving to the talking positions. These required but a single frequency assignment. Other installations used invariable sets in the cars and hence required two frequency assignments—one for communicating with the cars and the other for receiving from the cars. The car transmitters radiate from one to 10 watts. The equipment of a car for two-way communication as employed in Bayonne, New Jersey, is shown in Figs. 3 and 4. The vertical rod shown is used for the transmitting antenna.

Due to the short range of the car transmitters, a city of the size of Boston cannot, in the present state of the art, be served by such a two-way radio system. Here, while all cars probably can be reached from central transmitter, it will be possible to transmit from the cars only to their own station houses. Acknowledgment of orders will be made by the officer in charge in a car to the signal desk attendant who will also have received the broadcast from the central dispatcher to the car. In case the acknowledgment is not received promptly, the desk attendant will notify the dispatcher who will then be able to assign another patrol car.

Should the officer in charge of the patrol car desire to communicate directly with the dispatcher, he can request the signal desk attendant to so connect him. This is to be done by means of the cord circuits of the signal desk and the connecting trunks to the General Headquarters' dial switchboard and thence to the dispatcher. A two-way conversation using one wire and two radio links will be set up in that manner. Connection to any other telephone in the private departmental system can be made by the dispatcher. This will enable the Police Commissioner and other high police officials to talk directly from their offices or other points reached by the department's telephone system to the superintendent, detectives, or other officers in cars. Many emergencies arise where this sort of communication is very important.

To keep the mobile radio equipment in continuous operation requires the use of radio service cars. These are equipped with radio receivers for receiving orders as well as with spare tubes and parts and even spare receiving sets. Trouble with the radio set is reported to the dispatcher over the patrol-box telephone system, whereupon the service car is acquainted with the trouble by radio. The repair crew makes tube replacements and minor repairs in the field, but in case of major trouble the entire set is replaced.

The communication needs of a police department are thought by many to consist largely of radio. Without the wire lines of the public telephone and patrol-box systems to bring the alarms into the radio dispatcher's office, radio would be of little use. The teletype is of permanent value because of the fact that its written record leaves no opportunity for dispute as to what message was received. Two-way radio is to be expected more in the future if the present trend of development continues. None of these communications facilities, singly, are sufficient for the needs of a large municipal area, but each must supplement and reinforce the other, with the wire lines always the backbone of the system.

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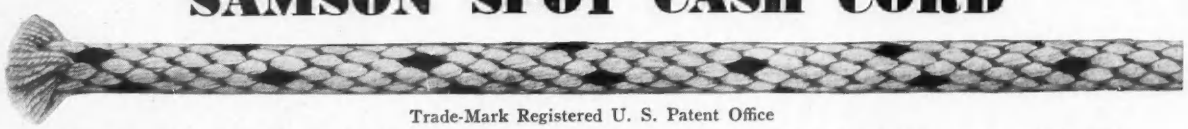

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